DOCUMENT RESUME

ED 272 135 IR 012 185

AUTHOR Miller, Richard B.
TITLE Diagnostic Testing and Individualized Instruction of Reasoning Skills.
PUB DATE [86]
NOTE 13p.
PUB TYPE Information Analyses (070) -- Reports - Descriptive (141)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS College Freshmen; *Diagnostic Teaching; Diagnostic Tests; Higher Education; *Individualized Instruction; *Logical Thinking; Problem Solving; *Skill Development
IDENTIFIERS *Reasoning Tests

ABSTRACT

Before a course to improve basic reasoning skills can be intelligently designed, it will be necessary to determine the exact nature of those skills. Research indicates that: (1) reasoning skills are highly specific, not generalized; (2) a large number of different reasoning skills exist; (3) many reasoning skills are language dependent and widely distributed; (4) patterns of weaknesses in reasoning skills are highly individual; and (5) reasoning skill weaknesses are very hard to change. In a normal lecture approach to reasoning skill instruction, the teacher decides how many skills to cover, then lectures on them in sequence; unfortunately, this type of instruction is ineffective given the specificity, the number, and the difficulty of these skills. The creative response to this situation is diagnostic testing and individualized instruction; students must be pretested to discover their individual patterns of strengths and weaknesses. If this is done, then instruction, homework, and even tests can be designed for individual students. The sequential instruction of reasoning skills in a lecture format is almost certain to fail; at most, there will be a reinforcement of existing skills in the better students and almost no genuine skill development in those who need it most. This paper briefly reviews the author's research in this area and describes in detail a pedagogical experiment based on his findings. (JB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
OERI
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)
☒ The document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official position or policy.

ED272135

Diagnostic Testing and Individualized Instruction of Reasoning Skills

Richard B. Miller

East Carolina University

IR012185

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Richard B. Miller

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ABSTRACT OF "Diagnostic Testing and Individualized Instruction of Reasoning Skills" by Richard B. Miller, Department of Philosophy, East Carolina University

The importance of reasoning skills instruction is widely recognized. Research into effective methods of such instruction must, in the author's opinion, be based on research into the nature of those skills. In this paper the author briefly summarizes the results of some early research which he has conducted on verifying existing theories of reasoning skills. The author's conclusions have lead him to design a reasoning skills development course for college students built around extensive diagnostic testing to determine the individual patterns of strengths and weaknesses of particular students and individualized instruction which concentrates the effort of both instructor and student where it is needed most.

IR012185

There is widespread concern with the failure of our students to acquire basic reasoning skills. This concern has fueled a nationwide movement to improve reasoning skills instruction. It is my belief that innovation in such instruction must be grounded in research into the nature of reasoning skills. Though tests of reasoning skills have been in existence for over twenty years very little has been done in the way of using the data gleaned from these tests to redesign them. What we really need are tests designed not to test the reasoning skills of students and, a fortiori, to test the success of programs which seek to improve those skills. Rather we need tests that are designed to gather data to test hypotheses about reasoning skills. The former kind of test would be far more reliable after extensive experience with the latter.

I have done some research along these lines and in this paper will report on the early and tentative results which I have gleaned and their implications for the teaching of reasoning skills. In the Spring of 1985 I gave the New Jersey Test of Reasoning Skills to 133 college freshmen. I analyzed the results not for information about those students but rather to see if the theory of reasoning skills implicit in the test was borne out by them. I soon found myself hampered by the fact that the test was not designed to test the theory, it was designed to test students. The results which I was able to glean from the test suggested that 1) I should redesign my courses to take account of the surprising degree of variation among students 2) I should

design a test specifically for the purpose of confirming or disconfirming hypotheses about reasoning skills. The second of these tasks I have had to postpone until the spring of 1986, but I am able to report on the first task in this paper.

I concentrated on formal logic in ordinary language because these are relatively well-understood and highly transferable. This also represents a compromise between symbolic logic and so called "informal logic." I do not believe that the skills embodied in formal logic are exhaustive of what should ultimately be included in reasoning skill instruction. Good reasoning involves both skills and dispositions. One must not only be <u>able</u> to think logically; one must also <u>want</u> to think logically and have the habit of taking a critical attitude toward the information/misinformation with which we are bombarded. I do try to cultivate in my students the critical attitude and the disposition to construct valid arguments as well as mere abilities, but I don't know how to measure attitudes and dispositions. At least not yet.

Before we can intelligently design a course which will improve basic reasoning skills we must give some thought to and do some empirical research into what those skills are. My research, admittedly tentative, into the nature of reasoning skills has lead me to some dramatic changes in the way I attempt to teach these skills. In this paper I will not describe that research in detail, but I will summarize the results that were relevant to the change in my teaching practice and describe in some detail the pedagogical experiment that has resulted.

CONCLUSIONS FROM EARLY RESEARCH

From my research I concluded that: (1) Reasoning Skills are highly specific, not generalized. (2) There are an enormous number of Reasoning skills. (3) Many Reasoning skills are language dependent. (4) Reasoning skills are widely distributed. (5) Patterns of weaknesses in reasoning skills are highly individual.

On the basis of my teaching experience I was able to add an additional conclusion (6) Reasoning skill weaknesses (bad habits of thinking) are very hard to change. Any real change requires individual attention on the part of the instructor and much practice on the part of the student.

(1) Reasoning skills are highly specific, not generalized. I have found on taxonomies of reasoning skills on which some of the major critical reasoning tests are based such items as "recognizing ambiguities," "evaluating evidence," "deductive reasoning," etc. My research indicates that this is far too general. A student who can do modus ponens cannot necessarily do modus tollens. When I analyzed the results of three questions designed to test the ability of students to recognize semantic ambiguities, I found that the correlations among these answers was exactly equal to chance, that is, a correct or incorrect answer on one such question had absolutely no predictive value for the other two. If there is a general skill at "recognizing ambiguities," then there should be strong correlations among these answers. I suspect, though further data is of course needed, that there are as many skills at recognizing

semantic ambiguities as there are ambiguous expressions in a given language. (I have no data on syntactic ambiguities and would not be surprised to find strong positive correlations there.)

(2) There are an enormous number of reasoning skills. This result is a consequence of the first. By splitting up the overly general reasoning skills of other taxonomies into distinguishable skills one multiplies the number of those skills. For example, there is no such thing as a genreal skill at "deductive reasoning." Within this broad category we must discriminate between modus ponens and modus tollens. At that level of discrimination there are dozens of distinguishable skills. I cannot with confidence estimate the number reasoning skills that will eventually be individuated, but I am confident that the order of magnitde will be in the hundreds (at the very least.)

(3) Many reasoning skills are language dependent. Research indicates that significant percentages of students (both college and pre-college) do not know what "only," "unless," "none except," etc. mean. The ability to correctly interpret such common words might not seem to be properly categorized as "reasoning skills," but if one lacks these skills, then one is unlikely to be able to use formal logic skills in the context of ordinary reading and speaking.

(4) Reasoning skills are widely distributed. Most of the skills for which I was testing were possessed by most of the students tested. In a sense this was exactly what we should expect. Basic reasoning skills are those which every college student should have. If the average student entered college with

few or none of these skills that would make college teaching virtually impossible. Luckily, college freshmen are not tabulae rasae. This was the good news. The bad news is that most students had serious deficiencies in their reasoning skills.

(5) Patterns of weaknesses in reasoning skills were highly individual. The average college student was only a little better at reasoning than the average junior high pupil. Some weaknesses were more common than others, but the skills did not divide up into a neat hierarchy. A student who was generally weak often had some of the least common skills, and a student who was generally strong often was missing some of the most common skills.

(6) Reasoning skill weaknesses are resistent to change. This conclusion was not a result of my research but rather of my experience at trying to teach reasoning skills. An individual student's weaknesses can be uncovered early and yet progress can be very slow. This might be due to the fact that an 18 year old may have practicing incorrect patterns of reasoning for years before anyone discovers this and attempts to change it. By then the force of habit and emotional resistence powerfully interfere with attempts to reprogram his or her thought patterns.

PEDAGOGICAL IMPLICATIONS OF THIS RESEARCH

The immediate result of these conclusions was that I saw that with a standard lecture approach to reasoning skills development one is caught in an impossible situation. In a normal lecture approach to reasoning skill instruction the

teacher decides how many skills to cover, then lectures on them in sequence. The lecturer seeks to make his explanation of each skill appropriate for the average student. This cannot work well given the specificity (result 1 above), the number (result 2 above), and the difficulty (result 6 above) of these skills.

Given the number of those skills to devote lecture time to each one would mean that only a few minutes could be devoted to each skill in the course of the semester. This is far too little time devoted to any one skill for a student who has developed a firmly engrained habit of, for example, affirming the consequent, to break the bad habit and replace it with the proper one. It takes a lot of hard work on the student's part to break bad habits. This in turn requires a great deal of motivation.

Yet students recognize the need and have good motivation at the start of a course in reasoning skills development. There is a nationwide phenomena of students eagerly signing up for such courses and volunteering as their reason that they recognize the fact that they need to learn to be more logical. Sadly, this motivation usually evaporates throughout the semester.

Result 4 both explains this fact and points to a creative solution. For each skill some, often many, of the students already possess it before the class began. In each case a few, and sometimes the majority, have a firmly engrained habit of illogical thinking that runs counter to the skill which we would try to impart. The result is a that sequential lecturing leaves the majority of students alternatively frustrated or bored. They are bored when the skill presented is one which they already possess. They are frustrated when it is a skill which they do

not possess because not enough time and attention are devoted to it for their needs. If the lecturer aims at a hypothetical "average" student he will succeed to satisfying the needs of none of his students. Small wonder that the initially good motivation of the students evaporates. Failure can be to some extent hidden by 1) students who are so highly motivated that they teach themselves despite the inefficient technique of the reasoning skills instructor, and 2) grading on the curve which reproduces the preexisting distribution of reasoning skills in the students prior to any instruction. Without pre-testing the second factor can easily be ignored.

The creative response to the situation is diagnostic testing and individualized instruction. Students must be pretested to discover their individual patterns of strengths and weaknesses. If this is done, then instruction, homework, and even tests can be individualized during the semester. Time and motivation are not wasted by forcing students to spend time working on skills which they already possess. The human energy, of the instructor as well as the student, can then be channelled into the demanding work of changing entrenched patterns of illogical thought.

The sequential instruction of reasoning skills in a lecture format is almost certain to fail. At most there will reinforcement of existing skills in the better students and almost no genuine skill development in those who need it most. Of course, we can still motivate some students to learn these skills on their own through the giving of grades, but that is virtually all one can do who designs a reasoning skill course

around lectures.

Ideally students could be given a complete diagnosis of their strengths and weaknesses at the start of the course. I have found that given the number of skills involed that such a test would be inordinately lóng. My solution is to give a series of six diagnostic tests throughout the semester.

My method is this. Before any instruction takes place students are given the first diagnostic test. It is immediately graded and the grades are kept by the instructor. Students are given only an answer key. They must then grade their own test to determine their own strengths and weaknesses. The next few classes are devoted to small group instruction on various areas of the test. For example, students needing work on conversion are told to gather in a group and given specific exercises keyed to their weakness. After a week of instruction the test is repeated and a new diagnostic test is given at the same time.

Students are allowed a great deal of freedom in self-diagnosis and selection of the method of learning that works best for them. A variety of approaches can be employed in the classroom but the one common denomimator is that the approach must be individualized. Students need work on only the skills which they do not possess. No time should be wasted on having a student listen to lectures or do exercises designed to teach him what he already knows. All available classroom time should be spent attacking specific individual weaknesses since these require so much time to correct.

The classroom space is divided up into areas in which students with a common weakness can gather to practice the skills

which they need. The instructor divides his time from group to group. Groups gain focus through the use of exercises. These consist of mimeographed problems of the same type as appear on the tests. These mimeos are made available to the groups depending on individual need. Since they consist of problems like those which will be on the next test there is a very clear and immediate motivation for the students to figure out the correct answers to these exercises. Much of the instructor's class time is spent in merely looking over the work and verifying that answers are correct. Often a given individual will require a few minutes of private tutoring. Personal attention by the instructor is very effective in helping students identify exactly what their weaknesses are and by eliminating wasted time I find that I can afford to offer many more students this educational luxury. Sometimes a whole group cannot get the hang of a skill and then I will be forced to give a mini-lecture to the group or do one or two sample problems for them. But these are kept short and are only offered in response to a request.

If every area of difficulty cannot be addressed in class sessions (as is often the case,) they are at least made aware of exactly where their difficulties lie and work sheets are available for homework. One extremely common practice is to tell aparticular student to go back and reread a particular portion of the text. Homework is an absolute necessity in logic and it is a perennial source of dissatisfaction. Teachers insist that the students need to do homework, the more the better, but the students resist doing it because it is very time consuming.

Spending hours doing homework problems designed to develop skills that one already has is the height of academic aridity. I am convinced that this is where much student motivation disappears. Individualizing the instruction provides a solution. It is a waste of time to do logic exercises which are designed to develop skills one already possesses. That is one reason why students resist doing homework. If students are diagnosed as to their precise weaknesses, they can be directed to do homework only on the kinds of problems that they really need. Students are more likely to do problems for which there is a specific need. I have not individualized homework assignments as much as I could, but this is a practice which I feel offers much promise in the future.

CONCLUSION

The basic ideas around which I have designed my reasoning skills course should be highly adaptable in other contexts. Pretesting students on the material which is to be covered in a course, or portion of a course, is a valuable teaching tool. It is not one with which every teacher will be comfortable. It takes away the illusion that everything a student knows on the final exam is something she has been taught. In such a situation a teacher is forced to take a realistic look at exactly how much each student has actually changed as a result of the course. But without this kind of information we cannot realistically assess our effectiveness.